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SF-15200 Lahti(FI)54 **A method of and a device for regulating the luminosity of a gas-discharge lamp, especially a fluorescent lamp.**

57 The invention relates to a method of and a device for regulating the luminosity of a gas-discharge lamp (2), especially a fluorescent lamp, according to which method the gas-discharge lamp (2) is supplied with alternating voltage (U1, U2) to be obtained from an alternating-voltage source (1). In order to be able to regulate the luminosity of the gas-discharge lamp in both directions within very wide limits without safety risks caused by high voltages or without disturbances caused by high rates

of change of the current, both electrodes (2a, 2b) of the gas-discharge lamp (2) are supplied from the alternating-voltage source (1) in such a way that the voltage level of each end of the lamp (2) is sufficient to cause a glow discharge at the end of the lamp (2) and the alternating-voltage signals (U1, U2) to be supplied are synchronized with each other and the synchronization between them is regulated for the regulation of the current flowing through the gas-discharge lamp (2).

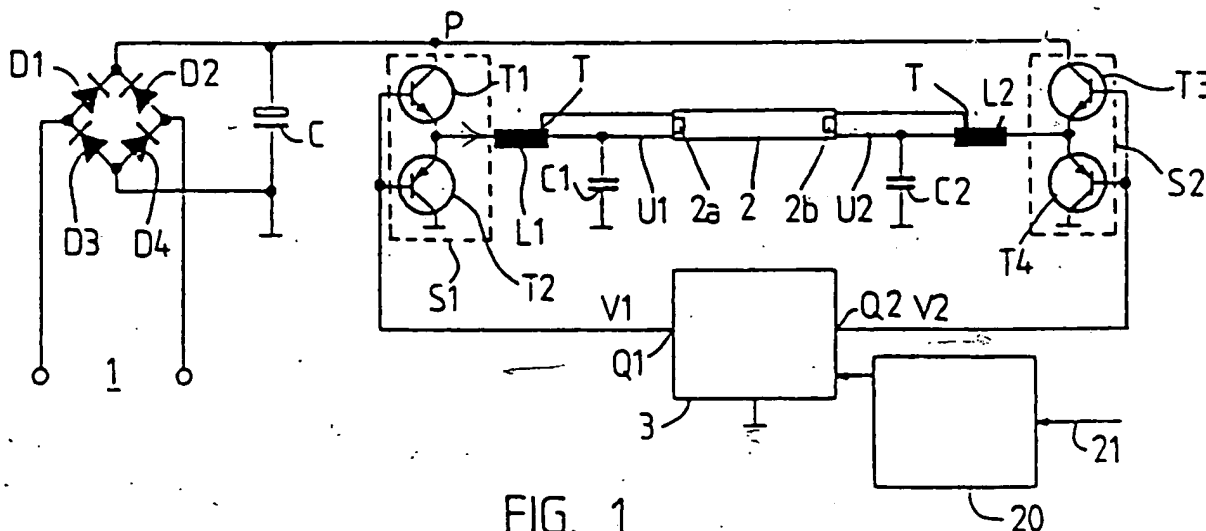


FIG. 1

The invention relates to a method of and a device for regulating the luminosity of a gas-discharge lamp, especially a fluorescent lamp. According to the method, the gas-discharge lamp is supplied with alternating voltage to be obtained from an alternating-voltage source, and the device according to the invention comprises an alternating-voltage source for supplying the gas-discharge lamp with alternating voltage.

Electronic regulating circuits for the regulation of the luminosity of a fluorescent lamp are known per se. Three groups can be separated from the regulating devices on the market: regulators utilizing conventional control engineering, electronic coupling devices to be regulated by means of a phase angle regulator and electronic coupling devices to be regulated by means of low voltage control.

A drawback of the known regulating circuits is in the first place that the lamp cannot be dimmed to a very low luminosity. When a bright lamp is regulated dimmer, the regulation can be carried out to a brightness level of typically about 5 %, but when regulated in the other direction the lamp cannot be made to light up until on a brightness level of about 20 to 30 %. The range of regulation and ignition of a fluorescent lamp has been made wider by using high voltage peaks (of typically about 1,5 kV) on low light levels and by glowing electrodes with constant voltage. In this manner, the lighting current of the fluorescent lamp can be regulated from 100 % to nearly 0 %, but drawbacks of the solution are the high voltage causing safety problems and strong disturbances caused by the voltage peaks. Additionally, high rates of change of the current wear the electrodes of the lamp.

The object of the present invention is thus to get rid of the drawbacks described above and to provide a method and a device, by means of which the luminosity of the gas-discharge lamp can be regulated in both directions within very large limits without safety risks caused by high voltages or without disturbances caused by high rates of change of the current or without the electrodes wearing. This is achieved by means of the method of the invention in such a way that both electrodes of the gas-discharge lamp are supplied from respective alternating-voltage source in such a way that the voltage level of both ends of the lamp is sufficient to cause a glow discharge at the end of the lamp, and that alternating-current signals to be supplied are synchronized with each other and the synchronization between them is regulated for the regulation of the current flowing through the gas-discharge lamp. The device of the invention is characterized in what is set forth in the characterizing portion of claim 4.

The basic idea according to the invention is to connect to both ends of a gas-discharge lamp an alternating voltage, the voltage level of which is sufficient to cause a glow discharge at the ends of the lamp, and to synchronize these signals with each other in such a way that an offset voltage effective over the lamp and thus also the current flowing through the lamp can be regulated for the regulation of the luminosity of the lamp.

By means of the solution of the invention a device with a simple construction is provided, by means of which the luminosity of the gas-discharge lamp can be regulated from a very low level of typically about 1 %, up to full luminosity. When regulating by the method of the invention, the voltage of the ends of the gas-discharge lamp is even at its maximum 400 to 500 V, i.e. considerably lower than that of the devices described above based on the use of ignition peaks. Because no made-up ignition peaks are needed in the method of the invention, disturbances caused by the device remain slight also.

In the following, the invention is described more closely referring to the example according to the enclosed drawing, in which

Figure 1 shows a circuit diagram of a device according to the invention,

Figures 2a to 2c show output signals of a phase regulating circuit shown in Figure 1, and

Figure 3 shows one way of realizing the phase regulation in the circuit according to Figure 1.

A regulating device shown in Figure 1 and functioning on a principle according to the invention is connected to an alternating-voltage source 1, which can be e.g. a conventional network of 110 or 220 V and 60 or 50 Hz. The device comprises in a manner known per se a full impulse wave bridge rectifier consisting of diodes D1 to D4 and a filter capacitor C, by means of which the alternating voltage of the voltage source 1 is rectified and filtered to achieve a direct voltage at a terminal P connected to switching elements S1 and S2 similar to each other. The switching element S1 comprises two push-pull connected transistors T1 and T2 and the switching element S2 two push-pull connected transistors T3 and T4, respectively. The output of the switching element S1 is connected in a manner known per se to an electrode 2a of a fluorescent lamp 2 through an oscillating circuit formed by a choke L1 and a capacitor C1. The object of the LC oscillator is to work a rectangular wave coming from the switch S1 to a sinoidal one, and thus, it is of no significance to the actual inventive idea. Correspondingly, the output of the switching element S2 is connected to an opposite electrode 2b of the fluorescent lamp through an oscillating circuit formed by a choke L2 and a capacitor C2. The electrodes 2a and 2b collect glow voltage from

taps T of the chokes L1 and L2 in a manner known per se.

The switching elements S1 and S2 are controlled by a phase regulating circuit 3 with two outputs indicated by reference numerals Q1 and Q2. The output Q1 is connected to the bases of the transistors T1 and T2 of the switching element S1 and the output Q2 to the bases of the transistors T3 and T4 of the switching element S2, respectively. The switches S1 and S2 are controlled by the output signals of the phase regulating circuit 3, and then the direct voltage at the collectors (point P) of the transistors T1 and T3, rectified and filtered from the supply voltage, is connected at a rate defined by them to the chokes L1 and L2. The signals to be supplied to the electrodes 2a and 2b are indicated by reference numerals U1 and U2.

In Figures 2a to 2c, output signals of the phase regulating circuit 3 are shown in such a way that signals V1 and V2 at the outputs Q1 and Q2 in Figures 2a and 2b are cophasal with each other, while they in Figures 2a and 2c are reversed-phasal with respect to each other. By means of the phase regulating circuit 3, the phase difference between the signals V1 and V2 can be regulated steplessly between 0° and 180°.

With a cophasal signal (U1 and U2, respectively) at both ends of the fluorescent lamp 2 in consequence of the control signals V1 and V2 of the Figures 2a and 2b, cophasal with each other, the offset voltage effective over the tube is zero; and therefore, no current can be generated through the tube. However, the voltage level of each end of the fluorescent lamp is according to the invention high enough to cause a glow discharge at the end of the lamp. The glow discharge is provided by a field generated between the electrode at the end of the tube and the body. Then there is a high voltage (about 500 V) between the electrode and the lamp body, but no voltage between the electrodes, and the fluorescent lamp has not lit up, because no current flows through it.

When a regulation of the phase angle of the voltages between the ends of the fluorescent lamp starts by regulating the phase difference between the control signals V1 and V2, an offset voltage depending on the phase difference between the signals V1 and V2 begins to be effective over the tube, and current begins to flow through the lamp. The maximum current and luminosity are achieved in a situation in which the control signals V1 and V2 are reversed-phasal according to the Figures 2a and 2c. By regulating the phase difference between the signals V1 and V2, the luminosity can be regulated steplessly in both directions.

Figure 3 shows one way of realizing the phase regulation in the circuit according to Figure 1. The essential point of the phase regulating circuit is a

pulse width modulator 10, which can e.g. be of the commercial type SG 3524. The pulse width modulator 10 gives pulses with adjustable width from two separate outputs Q3 and Q4 alternately, which pulses are distributed by means of dividers 11, connected to the outputs of the pulse width modulator, thus providing symmetric square waves at the outputs of the dividers, the phase between these waves being adjustable by controlling the pulse width modulator. The outputs of the dividers 11 are connected to the switches S1 and S2 through switches S3 and S4 corresponding to the switches S1 and S2 and through capacitors C3 and C4 as well as through transformer couplings M. The switches S3 and S4 connect the logic voltage level UC at the collectors of transistors T5 and T7 at a rate defined by the output signals of the dividers 11 to the switches S1 and S2 through the transformer couplings M. A galvanic separation by means of the transformer couplings has been arranged in order to protect the electronic parts from the voltage of the collectors (point P, Figure 1) of the transistors T1 and T3. By measuring the current of the fluorescent lamp in a known manner, for instance by means of a current measuring transducer 12, and by using this information as a measuring value to be connected to a measuring input 10a of the pulse width modulator 10, a coupling is provided by which the current can be stabilized in a known manner to a desired value. If the parameters of the system, such as the operating voltage, remain unchanged, the value of the current depends on the phase angle only, and then the regulation of the current can be realized simply in a known manner by means of digital engineering. The control of the pulse width modulator is illustrated in Figure 3 by indicating its regulating input with the reference numeral 10b.

The tube ends can collect glow current in a known manner by means of an additional coil from the chokes L1 and L2 or from the resonance current, in which way it is possible to make the regulator function at a lower operating voltage. Correspondingly, with this arrangement it is possible to effect a preglowing of about 500 to 1000 ms at the ignition phase of the fluorescent tube, before the fluorescent tube is allowed to light up. Because the current flowing through the fluorescent lamp is directly proportional to the phase angle, it is easy to connect separate regulators to each other for instance by means of an optical cable or another similar method, if a phase transfer is carried out by a divider or another accurate manner. Then it is for one thing possible to accomplish individual lighting for each working point in office e.g. by means of the central minicomputer and the PC of each working point by providing the regulator of each working point with an address of its own. For this possibil-

ity, a data receiver 20 is connected to the phase regulating circuit 3 of each regulator according to Figure 1, which receiver receives the control data coming from a bus 21. Data can also be transferred in the distribution network or by infrared remote control, for example.

Though the invention has been described above referring to the example according to the enclosed drawing, it is clear that the invention is not restricted to that, but it can be varied in many ways within the scope of the description above and the inventive idea presented in the enclosed claims. For one thing, the principle of the invention is not confined to the control of fluorescent lamps only, but in principle, a gas-discharge lamp of another type can also be used instead of a fluorescent lamp. The method of the invention is not confined to the coupling circuit described above either, the circuit comprising a bridge rectifier and transistor switches, but it shall be understood that it can be applied to any suitable coupling circuit. In principle, it is possible to apply the method of the invention also to standard chokes by synchronizing two alternating-voltage signals with a sufficient voltage level with each other in such a way that the current flowing through the lamp can be regulated. The realization of the phase regulating circuit, for example, can also vary in many ways according to solutions known per se in the field.

Claims

1. A method of regulating the luminosity of a gas-discharge lamp (2), especially a fluorescent lamp, according to which method the gas-discharge lamp (2) is supplied with alternating voltage (U1, U2) to be obtained from an alternating-voltage source (1), **characterized** in that both electrodes (2a, 2b) of the gas-discharge lamp (2) are supplied from the alternating-voltage source (1) in such a way that the voltage level of both ends of the lamp (2) is sufficient to cause a glow discharge at the end of the lamp (2), and that alternating-voltage signals (U1, U2) to be supplied are synchronized with each other and the synchronization between them is regulated for the regulation of the current flowing through the gas-discharge lamp (2).
2. A method according to claim 1, in which the alternating voltage to be obtained from the alternating-voltage source (1) is rectified and the alternating-voltage signal (U1, U2) worked from the obtained direct voltage is connected to the gas-discharge lamp (2), **characterized** in that the phase difference between said alternating-voltage signals (U1, U2) is regulated

for the regulation of the current flowing through the gas-discharge lamp (2).

3. A method according to claim 2, **characterized** in that the phase difference between the alternating-voltage signals (U1, U2) is regulated by controlling a switching element (S1, S2) producing the alternating-voltage signals from the direct voltage at a rate defined by control signals (V1, V2) adjustable with respect to the phase difference between them.
4. A device for regulating the luminosity of a gas-discharge lamp, especially a fluorescent lamp, which device comprises an alternating-voltage source for supplying the gas-discharge lamp (2) with alternating voltage (U1, U2), **characterized** in that it comprises an alternating-voltage source connected to each electrode (2a, 2b) of the gas discharge lamp (2), the voltage level given to the lamp (2) by an alternating-voltage signal (U1, U2) of the source being sufficient to cause a glow discharge at the end of the lamp (2), and means (3) for an adjustable synchronization of the alternating-voltage signals (U1, U2) with each other to regulate the current flowing through the gas-discharge lamp (2).
5. A device according to claim 4, comprising means (D1 to D4; C) for rectifying the alternating voltage to be obtained from the alternating-voltage source, and means (S1, S2) for connecting the alternating-voltage signal (U1, U2) worked from the obtained direct voltage to the gas-discharge lamp (2), **characterized** in that at each end of the gas-discharge lamp (2) are arranged corresponding switching elements (S1, S2), and that to each switching element (S1, S2) is connected the output (Q1 or Q2) of the phase regulating circuit (3) in such a way that the phase difference between the control signals (V1, V2) at said outputs can be regulated.

